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(56) Documents Cited

GB 2192136 A

GB 2176405 A

GB 1490974 A

GB 1448473 A

GB 1294808 A

EP 0190080 A2

US 5349946 A

US 5284160 A

(58) Field of Search

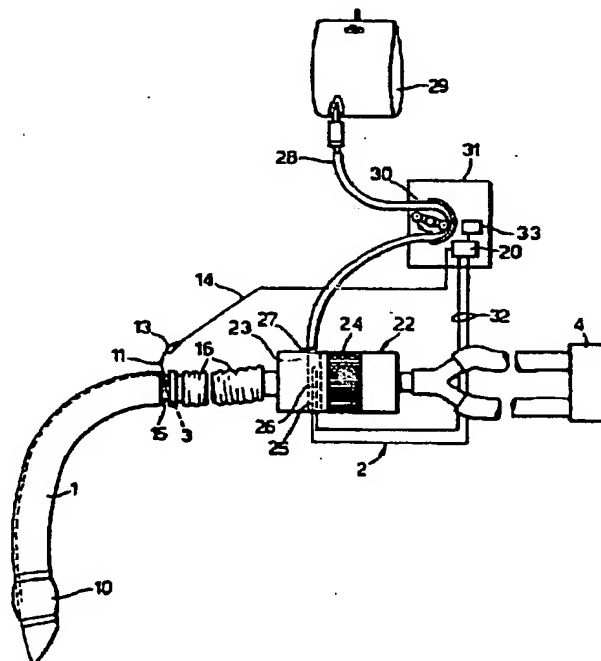
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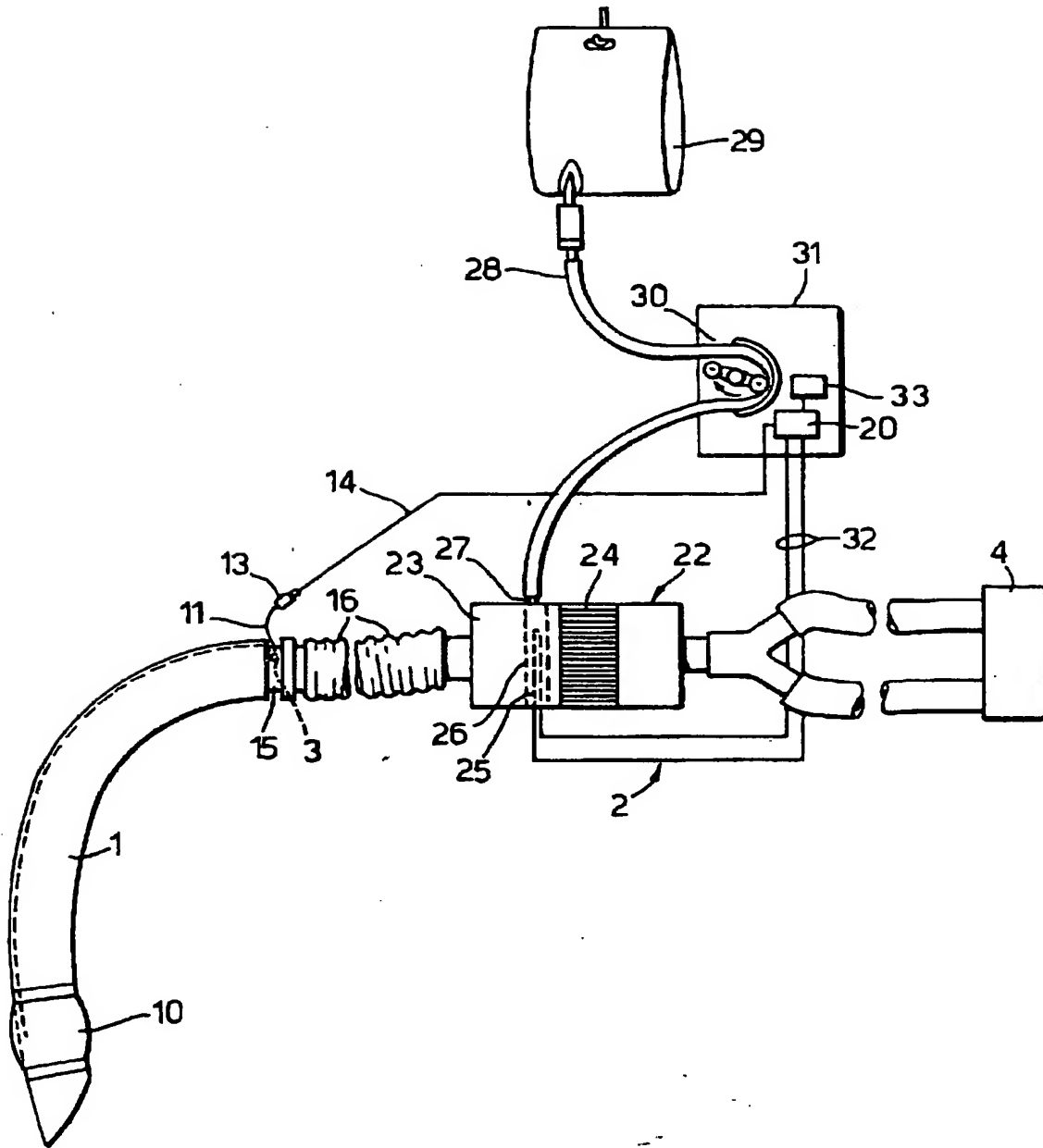
## (54) Humidifier system with humidity sensor

(57) The system has a heat and moisture exchange device 22 supplied with water from a pump 30, the water being heated by a heater 25. Gas from a ventilator 4 is supplied to the patient via the exchange device and via a tracheal tube 1 which receives the humidified gas by way of tubing 16 and a connector 15. The latter is mated with the machine end of the tracheal tube and includes a humidity sensor 3, the output of which controls humidification by controlling the speed of the pump 30 or the temperature of heater 25.



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**HUMIDIFIER SYSTEMS**

This invention relates to humidifier systems.

Humidifier systems comprising a humidifier and a tracheal tube or mask are used to increase the humidity of gas supplied to a patient.

Examples of such systems are described in WO 91/19527 and 9522267. The humidifier usually incorporates a heater arranged to vaporize liquid water. The heater may be self-regulating or a separate temperature sensor may be provided to indicate the temperature of gas supplied to the patient. The humidity can be varied by altering the rate of water flow to the humidifier and this can be controlled in response to sensed temperature. This does not, however, provide a very accurate control of humidity.

It is an object of the present invention to provide a system that can be used to provide improved humidity control.

According to the present invention there is provided a humidifier system comprising a humidifier, gas supply means connected to the humidifier to supply humidified gas to the patient, and humidity sensor means connected in the gas supply means to provide an output representative of the humidity of gas supplied to the patient.

The gas supply means may include a tube and a connector connected with the tube, the humidity sensor being mounted in the connector. The tube may be a tracheal tube, the gas supply means including tubing connected between the machine end of the tracheal tube and the humidifier, and the connector being connected between the tracheal tube and the tubing. The output of the humidity sensor is preferably connected to the humidifier to control humidification of the gas. The humidifier may include a heat and moisture exchange device, a

supply of water to the exchange device and a heater for heating the water supplied to the exchange device. The humidifier may include a water pump, the output of the humidity sensor being connected to control the speed of the pump. The output of the humidity sensor may be connected to control the temperature of the heater.

A humidifier system according to the present invention will now be described, by way of example, with reference to the accompanying drawing, which shows the system schematically.

The system comprises a tracheal tube 1, or other breathing device, connected to humidifier apparatus 2 controlled by a humidity sensor 3. The system is connected to ventilator apparatus 4.

The tracheal tube 1 is of conventional construction, having an cuff 10 around its patient end, which seals with the trachea when inflated. At its machine or proximal end, the tube 1 is connected to a connector 15. The connector 15 includes a humidity sensor 3 exposed to gas flowing along the interior of the connector and hence along the tube. A wire 11 extends from the sensor 3 and is connected via a coupling 13 to a cable 14 extending to a control unit 20 of the humidifier apparatus 2. The sensor 3 could be mounted at various other locations such as, in the tube 1 itself, for example at its patient end, or in flexible tubing 16 connected to the connector 15.

The flexible tubing 16 extends to a heat and moisture exchange (HME) device 22 forming a part of the humidifier apparatus 2. The device 22 has an outer housing 23 and an exchange element 24 made of paper or foam plastics treated to be hygroscopic. On the patient side of the exchange element 24, within the housing 23, there is an electrical heater 25 covered by an absorbent wick 26. A water inlet 27 is located close to the wick 26 and is connected via tubing 28 to a water reservoir in the form of a suspended bag 29 of sterile water. The tubing 28 passes through a peristaltic pump 30 contained within the same housing 31 as the control unit 20. The control unit 20 controls the speed of the pump 30 and also provides power output

to the heater 25 via a lead 32. Various displays may be provided on the housing 31, such as a display 33 of humidity, as sensed by the sensor 3.

In operation, the ventilator 4 supplies gas to the patient via the HME device 22 and gas supply means comprising the tubing 16, connector 15 and the tracheal tube 1. Exhaled gas flows from the patient towards the ventilator 4 through the exchange element 24 to which it gives up a large part of its heat and moisture. Inhaled gas flows in the opposite direction through the exchange element 24 and, because it is relatively cool and dry, it takes up heat and moisture from the exchange element. The heat and moisture of the inhaled gas, after passing through the exchange element 24 is supplemented by heat from the heater 25 and moisture evaporated from the wick 26.

The level of humidity of gas supplied to the patient may vary for several reasons, such as, increased respiration rate, change in ambient temperature, or change in performance of the exchange element 24 with time. Any such change in humidity is sensed by the sensor 3 and signalled to the control unit 20. A fall in humidity causes the control unit 20 to increase the speed of the peristaltic pump 30 so as to increase the flow of water to the HME device 22; it may also increase the temperature of the heater 25 to increase the rate of evaporation from the wick 26.

Various modifications are possible. For example, the humidity sensor could be mounted in the HME device 22 or on a separate probe that can be inserted in the tracheal tube 1, as desired, through, for example, a suctioning port in an angled coupling.

**CLAIMS**

1. A humidifier system comprising a humidifier, gas supply means connected to the humidifier to supply humidified gas to the patient, and humidity sensor means connected in said gas supply means to provide an output representative of the humidity of gas supplied to the patient.
2. A humidifier system according to Claim 1, wherein the gas supply means includes a tube and a connector connected with the tube, and wherein the humidity sensor means is mounted in said connector.
3. A humidifier system according to Claim 2, wherein the tube is a tracheal tube, and wherein the gas supply means includes tubing connected between the machine end of the tracheal tube and the humidifier, and wherein the connector is connected between the tracheal tube and the tubing.
4. A humidifier system according to any one of the preceding claims, wherein the output of the humidity sensor means is connected to the humidifier to control humidification of the gas.
5. A humidifier system according to any one of the preceding claims, wherein the humidifier includes a heat and moisture exchange device, a supply of water to the exchange device and a heater for heating the water supplied to the exchange device.

6. A humidifier system according to Claim 5, wherein the humidifier includes a water pump, and wherein the output of the humidity sensor means is connected to control the speed of the pump.
7. A humidifier system according to Claim 5 or 6, wherein the output of the humidity sensor means is connected to control the temperature of the heater.
8. A humidifier system substantially as hereinbefore described with reference to the accompanying drawing.
9. Any novel feature or combination of features as hereinbefore described.



# The Patent Office

Application No: GB 9600483.3  
Claims searched: 1-8

Examiner: L.V. Thomas  
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## Patents Act 1977 Search Report under Section 17

### Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): A5T (TDB); B1R (RAGA)

Int Cl (Ed.6): A61M 16/00, 16/10, 16/16

Other: Online: WPI

### Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB 2192136 A (Virotherm Labs.) see p.1 ll.27-51 and 89-105	1,2,4,5,7
X	GB 2176405 A (Fisher & Paykel) see p.1 ll.14-42 and p.3 ll.2-39	1,2,4-6
X	GB 1490974 (Fodor) see p.1 ll.48-66, p.2 ll.23-31 and 44-47 and p.3 ll.29-42	1,3-7
X	GB 1448473 (Grant) see p.2 ll.41-67 and 91-94 and p.4 ll.87-94	1,4,5,7
X	GB 1294808 (Philips) see p.1 ll.59-84 and p.2 ll.65-102	1,4,5,7
X	EP 0190080 A2 (Virox) see p.2 l.32 - p.3 l.7, p.4 ll.11-18 and p.12 ll.1-16	1,2,4,5,7
X	US 5349946 (McComb) see col.2 ll.8-45 and col.3 ll.7-61	1-5
X	US 5284160 (Dryden) see col.4 ll.7-16 and col.8 ll.25-36	1-4

X Document indicating lack of novelty or inventive step  
Y Document indicating lack of inventive step if combined with one or more other documents of same category.

& Member of the same patent family

A Document indicating technological background and/or state of the art.  
P Document published on or after the declared priority date but before the filing date of this invention.  
E Patent document published on or after, but with priority date earlier than, the filing date of this application.